can in turn help to increase groundwater discharge to the stream channel that enhances base flows.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '97 and '98 CALFED Restoration Coordination Program funds were provided to allow the purchase of fee title or conservation easement on riparian properties that will protect existing riparian habitat or allow restoration of degraded or absent riparian habitat.

ACTION 5: In conjunction with the local watershed conservancy and local, state, and federal agencies, develop an implement a watershed management plan to reduce the transport of fine sediments to the creek channel, to protect and restore riparian habitat to improve base flows, to reduce water temperatures, and to reduce the ecological risk associated with catastrophic events.

RATIONALE: Activities in the Deer Creek watershed can increase erosion rates and introduce excessive loads of fine sediments to the creek channel. Untimely pulses of fine sediments can clog or bury spawning gravels, suffocating the incubating eggs of anadromous fish or preventing salmonid fry from emerging from the gravels. Fine sediments can also fill in the deep water pools that adult spring-run chinook salmon and steelhead trout require to survive high summer temperatures. Developing a watershed management plan to manage road construction, timber harvest and cattle grazing in the watershed can help prevent the introduction of too many fine sediments to the creek channel. Managing the fuel load in the watershed can also help prevent catastrophic wildfires that can denude vast areas of vegetation.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed
- evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel
- as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow
- as riparian vegetation is restored, evaluate its effects upon water temperatures

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '97 and '98 CALFED Restoration Coordination Program funds were provided to help manage erosion caused by road construction in the watershed. Funds have also been provided for the development of a watershed management plan that includes:

- managing grazing and meadow restoration to help prevent erosion in the watershed,
- managing of fuel loads to help prevent catastrophic wildfires, and
- developing a contingency plan to address spills of hazardous material into the creek channel.

CLEAR CREEK STAGE 1 ACTIONS

Clear Creek has the potential to be a demonstration stream, representative of northern Sacramento Valley tributaries that drain the Coast Range. Demonstration streams will be selected for large-scale implementation of restoration actions to significantly restore ecological processes and resources while simultaneously testing restoration hypotheses as part of an adaptive management approach. The objective for demonstration streams is to fully restore the tributary within existing constraints (such as large dams) by accounting for all major stressors that affect the ecological health of the tributary. Lessons learned restoring Clear Creek will help the design and refinement of future restoration actions on Clear Creek and other Bay-Delta tributaries.

Clear Creek has potential as a demonstration stream for several reasons. Clear Creek provides habitat for several special-status species, including spring-run and fall-run chinook salmon and steelhead trout. Whiskeytown Reservoir offers the potential to release flows of cold water, which is important for providing fish passage and maintaining holding and rearing habitat for special-status fish species. Much of the land surrounding lower Clear Creek is publicly owned

and managed by state and federal agencies, which generally provides greater restoration opportunities by minimizing conflicts with private land use. For instance, there is relatively little development along lower Clear Creek so that allowing the creek to meander across a portion of its floodplain will not require displacing homes or infrastructure. Clear Creek may also offer the opportunity to release channel maintenance flows that reactivate fluvial processes as a means of sustaining habitat conditions. Clear Creek also has an active watershed group composed of local landowners and local, state and federal agency personnel, which can help to catalyze restoration efforts.

ACTION 1: Remove the McCormick-Saeltzer diversion dam to provide greater access to upstream habitat, to restore sediment transport processes, and to reduce predator habitat.

RATIONALE: Saeltzer Dam is located on Clear Creek roughly 6 miles upstream of the confluence with the Sacramento River, and approximately 10 miles downstream of the much larger Whiskeytown Reservoir. The dam is approximately 15 feet tall, so during periods of low flow, it impedes the upstream migration of adult anadromous fish. In the past, the dam has been equipped with fish ladders to provide upstream passage, but they have been largely ineffective. The dam also interrupts the transport of sediment by trapping coarse sands and gravels derived from upstream reaches, thereby depriving lower Clear Creek of important spawning gravels. Purchasing the water right and removing the dam, or replacing the dam with a screened diversion, can restore fish access to upstream habitat and the transport of coarse sediments to downstream reaches.

The upstream reaches of Clear Creek between Whiskeytown Dam and Saeltzer Dam provide habitat that can meet the relatively stringent needs of adult spring-run chinook salmon and steelhead trout, two species that require deep cold-water pools to survive high summer temperatures as they hold in the creek waiting to spawn. Since there are few streams in the Central Valley that can provide the summer holding habitat that spring-run chinook and steelhead trout need, improving access to nearly 10 miles of upstream habitat in Clear Creek is an important opportunity.

Fall-run chinook salmon generally spawn in the lower reaches of Clear Creek downstream of Saeltzer Dam, so the dam does not impede their access to spawning habitat. However, the dam does degrade downstream spawning habitat by trapping gravel that would otherwise help replenish and maintain spawning habitat in lower Clear Creek. Replacing the current dam with an alternative diversion structure that allows the transport of sediment will allow gravels that have accumulated behind the dam to be transported to downstream reaches of the creek and eventually to the Sacramento River.

By impounding water at low flows, the dam can also provide warm water habitat that favors non-native or invasive species that prey upon rearing or emigrating juvenile salmonids.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Compare use of available spawning habitat upstream of the dam by anadromous fish before and after re-configuration of the diversion facilities.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

Both CVPIA and FY '97 CALFED Restoration Coordination Program funds have been provided to allow the evaluation, design and construction of an alternative water diversion that would allow removal of Saeltzer Dam.

ACTION 2: Augment the supply of spawning-sized gravel in the Clear Creek channel.

RATIONALE: Clear Creek has been deprived of its historical sediment load by dams that trap coarse sediment from upstream sources and by extensive gravel mining in the lower reaches of the creek. In recent years, gravel mining operations have been moved from the active channel by a county ordinance, which has improved downstream aquatic habitat. However, Whiskeytown Reservoir will continue to trap all of the coarse sediment derived from the upper watershed. Several gravel augmentation projects have been completed or

proposed for Clear Creek; however, as high flows transport introduced gravels down the creek channel into the Sacramento River, it will be necessary to introduce additional gravels to the channel. During Stage 1, it will be important to monitor the availability of spawning gravels and to augment gravel supplies as needed.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Monitor the transport and deposition of spawning gravels.
- Evaluate introduced spawning gravels to see if they are suitably sized for spawning habitat for anadromous fish.

ACTION 3: Fill instream mining pits and isolate floodplain gravel mining pits from the active channel.

RATIONALE: The extraction of gravel from instream and floodplain deposits has formed large pits that can strand juvenile salmonids emigrating from the creek and eliminate a clearly defined channel for adult upstream migration. The instream pits and captured floodplain pits provide warm water habitat for non-native and invasive species that prey upon juvenile salmonids attempting to emigrate from the creek. Filling instream and captured floodplain pits, or bolstering levees and berms that protect floodplain mining pits, will reduce the warm water habitat that favors predators.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Monitor the transport and deposition of spawning gravels.
- Evaluate introduced spawning gravels to see if they are suitably sized for spawning habitat for anadromous fish.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '98 CALFED Restoration Coordination Program funds were provided to fill in and isolate downstream gravel pits to prevent the predation and stranding of juvenile anadromous fish by using dredger tailings from upstream reaches which will allow the restoration or riparian habitat on the upper reach.

ACTION 4: Provide sufficient scouring flows to periodically remove vegetation that has encroached within the active channel in lower Clear Creek, and mechanically remove vegetation if necessary.

RATIONALE: Whiskeytown Dam has altered the Clear Creek flow regime by reducing peak flows. As a result, riparian vegetation has encroached into the active creek channel since the reduced peak flows are insufficient to naturally scour the vegetation. The encroaching vegetation helps to prevent the creek from meandering much like levees do. A naturally meandering river helps to create and maintain important aquatic habitat such as cutbanks and pools (valuable to rearing juvenile fish) and point bar deposits (valuable for colonization by riparian plant species). Periodically increasing peak flows in the downstream channel will provide the energy required to drive channel migration and to restore the natural process of riparian succession, which can provide more diverse aquatic and riparian habitat. Much like levees, vegetation that has encroached upon the active channel can confine flows to a relatively narrow channel, thereby increasing water velocity and the shear stress applied to sediments on the channel bed. This increased shear stress can flush spawning gravels downstream, thereby depriving the local reach of important habitat material.

Since years of reduced peak flows have allowed vegetation to firmly establish in the active channel, it may be necessary to mechanically remove encroaching vegetation to assist the natural scouring process.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Determine flows necessary to scour encroaching vegetation from the active channel.
- Determine channel maintenance flows necessary to scour and transport sediment to provide surfaces for riparian vegetation succession.

ACTION 5: Refine and implement a watershed management plan to reduce the transport of fine sediment to the creek channel and to protect and restore riparian habitat in conjunction with local landowners and local, state and federal agencies active in the watershed.

RATIONALE: Activities in the Clear Creek watershed can increase erosion rates and introduce excessive loads of fine sediments to the creek channel. Untimely pulses of fine sediments can clog or bury spawning gravels, suffocating the incubating eggs of anadromous fish or preventing salmonid fry from emerging from the gravels. Fine sediments can also fill in the deep water pools that adult spring-run chinook salmon and steelhead trout require to survive high summer temperatures. Developing a watershed management plan to manage road construction, timber harvest and cattle grazing in the watershed can help prevent the introduction of too many fine sediments to the creek channel. Managing the fuel load in the watershed can also help prevent catastrophic wildfires that can denude vast areas of vegetation.

Current land use practices in the upper watershed increase rates of erosion, introducing excessive loads of fine sediments that degrade habitat in the upper tributaries of Clear Creek. Re-introducing steelhead trout above Whiskeytown Reservoir will require better management of activities to decrease the transport of fine sediments to stream channels.

Developing a watershed management plan that protects and restores riparian vegetation can provide several ecological benefits. In addition to providing habitat for a variety of wildlife species, riparian buffers can help to trap fine sediments from reaching the stream channel. Riparian vegetation can also help reduce stream temperatures by providing shading, especially for pools that adult spring-run chinook salmon and steelhead trout use for holding during the summer. Riparian vegetation also helps create cutbanks that provide important rearing habitat for juvenile salmonids. Riparian vegetation also provides nutrients and woody debris to the creek channel, helping to stimulate food production and to provide diverse aquatic habitat.

Riparian vegetation can also help to retain stormwater runoff, helping to reduce peak flows in the channel and the concomitant flood risk to downstream reaches. Retention of stormwater runoff can also help increase the amount of water that percolates into groundwater aquifers, which can in turn help to increase groundwater discharge to the stream channel that enhances base flows.

An active watershed management group, the Lower Clear Creek Watershed Conservancy, has already developed a watershed management plan that will help to guide restoration efforts in lower Clear Creek.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed
- evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel
- as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow
- as riparian vegetation is restored, evaluate its effects upon water temperatures

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

NRCS conducted an evaluation of the Lower Clear Creek watershed.

ACTION 6: Evaluate the need to augment flows in Clear Creek and acquire water from willing sellers. (This water will be part of the 100 TAF acquired to improve streamflow in the Sacramento and San Joaquin Basins.)

RATIONALE: Whiskeytown Reservoir provides a source of water to help provide minimum instream flows necessary to allow fish passage over obstacles and to reduce stream temperatures. CVPIA provides for flows necessary to maintain ecological resources. It may be necessary to augment these flows to achieve more optimal conditions by purchasing water from willing sellers.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Determine the flows necessary to provide fish passage over obstacles
- Evaluate the relationship between flows and water temperatures
- Determine the flows necessary to transport and cleanse spawning gravels

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

CVPIA allocates flow releases from Whiskeytown and Clair Hill Reservoirs.

MILL CREEK STAGE 1 ACTIONS

Mill Creek is a relatively healthy tributary since its upper reaches flow through an inaccessible, undeveloped canyon. Since it drains volcanic lands surrounding Mount Lassen, Mill Creek has relatively higher flows throughout the summer and fall because it is fed by underground springs of cold water, which helps to provide important holding habitat for spring-run chinook salmon and steelhead trout. Indeed, Mill Creek is one of the few Central Valley streams that provides appropriate habitat conditions for spring-run chinook salmon and steelhead trout.

ACTION 1: Reduce or eliminate the need to reconstruct Clough Dam by providing an alternative diversion structure that does not impede the migration of anadromous fish.

RATIONALE: Clough Dam is one of three diversion structures on Mill Creek that can delay or impede the migration of anadromous fish. Clough Dam was breached during the floods of '97, providing an opportunity to remove the dam by developing an alternative diversion structure that does not impede fish migration.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

Since the dam has already been breached naturally, there is relatively little opportunity to design an adaptive management experiment to improve our knowledge of local ecological relationships and functions related to fish obstruction, other than continuing to monitor escapement rates and compare against historical data.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '98 CALFED Restoration Coordination Program Funds have been provided for the design, evaluation and construction of an alternative diversion structure that will eliminate the need to reconstruct the dam.

ACTION 2: Acquire water from willing sellers or develop alternative water supplies to provide sufficient instream flows to allow the upstream migration of adult anadromous fish. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins.

RATIONALE: In the past, water diversions from lower Mill Creek have de-watered the stream channel and prevented the upstream migration of adult anadromous fish. In recent years, landowners have worked with DFG and DWR through the Four Pumps Agreement to provide instream flows, in part by developing alternative water supplies for the water diverters. To ensure long-term water supplies that will provide adequate passage flows of suitable temperatures, it will be necessary to acquire water from willing sellers or to work with local diverters to develop alternative water supplies that will allow more water to stay in the channel.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Determine the flows necessary to provide fish passage over obstacles
- Evaluate the relationship between flows and water temperatures
- Determine the flows necessary to transport and cleanse spawning gravels

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ACTION 3: In conjunction with the local watershed conservancy and local, state, and federal agencies, develop and implement a watershed management plan to reduce the transport of fine sediments to the creek channel, to protect and restore riparian habitat to improve base flows, and to reduce water temperatures.

RATIONALE: Activities in the Mill Creek watershed can increase erosion rates and introduce excessive loads of fine sediments to the creek channel. Untimely pulses of fine sediments can clog or bury spawning gravels, suffocating the incubating eggs of anadromous fish or preventing salmonid fry from emerging from the gravels. Fine sediments can also fill in the deep water pools that adult spring-run chinook salmon and steelhead trout require to survive high summer temperatures. Developing a watershed management plan to manage road construction, timber harvest and cattle grazing in the watershed can help prevent the introduction of too many fine sediments to the creek channel. Managing the fuel load in the watershed can also help prevent catastrophic wildfires that can denude vast areas of vegetation.

Developing a watershed management plan that protects and restores riparian vegetation can provide several ecological benefits. In addition to providing habitat for a variety of wildlife species, riparian buffers can help to trap fine sediments from reaching the stream channel. Riparian vegetation can also help reduce stream temperatures by providing shading, especially for pools that adult spring-run chinook salmon and steelhead trout use for holding during the summer. Riparian vegetation also helps create cutbanks that provide important rearing habitat for juvenile salmonids. Riparian vegetation also provides nutrients and woody debris to the creek channel, helping to stimulate food production and to provide diverse aquatic habitat.

Riparian vegetation can also help to retain stormwater runoff, helping to reduce peak flows in the channel and the concomitant flood risk to downstream reaches. Retention of stormwater runoff can also help increase the amount of water that percolates into groundwater aquifers, which can in turn help to increase groundwater discharge to the stream channel that enhances base flows and helps reduce water temperatures.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed
- evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel
- as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during baseflow
- as riparian vegetation is restored, evaluate its effects upon water temperatures

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '97 and '98 CALFED Restoration Coordination Program funds were provided to help manage erosion caused by road construction in the watershed, and to purchase fee title or conservation easements for riparian properties that will protect or restore riparian habitat.

BATTLE CREEK STAGE 1 ACTIONS

ACTION 1: Improve fish migration by removing diversion dams, upgrading fish passage facilities, and screening diversions.

RATIONALE: PG&E owns and operates two small reservoirs and seven unscreened diversions on Battle Creek and its tributaries. The facilities can impede the migration of juvenile and adult anadromous fish, and the unscreened diversions can entrain juvenile anadromous fish. Before hydropower development, Battle Creek was one of the most important spawning streams in the Central Valley for several species of chinook salmon. Various species of chinook salmon and steelhead trout still utilize spawning habitat in lower Battle Creek; however, generally there is too little habitat available for the available populations of fish. Removing diversion dams or upgrading their fish ladders can provide access to upstream habitat and relieve pressure on the over-utilized downstream reach of the creek. Battle Creek is one of the few Central Valley streams that provides the cold-water pool habitat that spring-run chinook and steelhead trout require for surviving high summer temperatures.

As greater access to upstream habitat is provided to adult anadromous fish, it will be necessary to screen the several unscreened diversions that can

entrain juvenile salmonids.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Compare escapement rates and use of spawning habitat upstream of diversion facilities before and after removal.
- Compare use of available spawning habitat above hydropower facilities before and after construction of fish passage facilities.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '97 CALFED Restoration Coordination Program funds were provided for the evaluation and design of several screened diversions on Battle Creek and its tributaries.

ACTION 2: Improve instream flows in lower Battle Creek to provide adequate passage flows.

RATIONALE: The PG&E hydropower facilities on Battle Creek were capable of diverting up to 98% of the streamflow, which impeded fish passage and elevated stream temperatures. An interim agreement provided for re-operation of the hydropower facilities to provide a greater volume of flow. It is important to provide a long-term solution to ensure adequate streamflows downstream of the hydropower facilities.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Determine the flows necessary to provide fish passage over obstacles
- Evaluate the relationship between flows and water temperatures
- Determine the flows necessary to transport and cleanse spawning gravels

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

CVPIA funds have helped to provide interim flows until a long-term flow agreement is reached.

ACTION 3: Develop and implement a watershed management plan to reduce the amount of fine sediments introduced to the creek channel, to protect and restore riparian habitat, to improve base flows, and to reduce water temperatures

RATIONALE: Activities in the Battle Creek watershed can increase erosion rates and introduce excessive loads of fine sediments to the creek channel. Untimely pulses of fine sediments can clog or bury spawning gravels, suffocating the incubating eggs of anadromous fish or preventing salmonid fry from emerging from the gravels. Fine sediments can also fill in the deep water pools that adult spring-run chinook salmon and steelhead trout require to survive high summer temperatures. Developing a watershed management plan to manage road construction, timber harvest and cattle grazing in the watershed can help prevent the introduction of too many fine sediments to the creek channel. Managing the fuel load in the watershed can also help prevent catastrophic wildfires that can denude vast areas of vegetation.

Developing a watershed management plan that protects and restores riparian vegetation can provide several ecological benefits. In addition to providing habitat for a variety of wildlife species, riparian buffers can help to trap fine sediments from reaching the stream channel. Riparian vegetation can also help reduce stream temperatures by providing shading, especially for pools that adult spring-run chinook salmon and steelhead trout use for holding during the summer. Riparian vegetation also helps create cutbanks that provide important rearing habitat for juvenile salmonids. Riparian vegetation also provides nutrients and woody debris to the creek channel, helping to stimulate food production and to provide diverse aquatic habitat.

Riparian vegetation can also help to retain stormwater runoff, helping to reduce peak flows in the channel and the concomitant flood risk to downstream reaches. Retention of stormwater runoff can also help increase the amount of water that percolates into groundwater aquifers, which can in turn help to increase groundwater discharge to the stream channel that enhances base flows.

Creating a watershed management group can help bring together private landowners and local stakeholders with local, state, and federal agency personnel to help develop and coordinate watershed management activities. The watershed

group can provide a focused forum for the exchange of ideas and for building consensus among stakeholders, helping to provide a structure for continued public participation in decision making and to help build public support for long-term ecosystem restoration and management.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

Category III funds were provided to help establish a Battle Creek Watershed Conservancy.

ACTION 4: Improve the fish passage facilities at the Coleman National Fish Hatchery.

RATIONALE: Coleman National Fish Hatchery has a weir equipped with a fish ladder. The fish ladder provides access to upstream spawning habitat for spring-run and winter-run chinook salmon. The weir is designed to prevent fall-run chinook salmon from migrating upstream to spawn to prevent hybridization of the species. Improving the weir to better block upstream access to fall-run chinook salmon will help to preserve the genetic integrity of Battle Creek salmonids.

ACTION 5: Improve hatchery management and release practices at the Coleman National Fish Hatchery to better protect the genetic integrity of wild anadromous fish populations.

RATIONALE: Fish hatcheries in the Central Valley help to mitigate for fisheries losses attributed to dams that block access to historical spawning grounds and the degradation of habitat. Hatcheries can provide a valuable function by helping to maintain commercial and sport fisheries and by augmenting wild populations of fish that decline during adverse conditions such as droughts, thereby helping to ensure the survival of the species. However, hatchery produced fish can compete with wild populations for available resources such as food and spawning and rearing habitat. Hatchery produced fish may also prey upon wild populations of juvenile anadromous fish. The selection of fish used as hatchery stock may not represent an appropriate cross section of the population, which can reduce genetic diversity. Hatchery-produced fish also spawn with wild populations, reducing threatening the genetic integrity of wild populations of fish.

Reducing the number of hatchery-produced fish released into Bay-Delta tributaries in years when the natural production of fish is high can help prevent competition among wild and hatchery-reared fish and help populations of wild fish to rebound naturally. It can also help to reduce inter-breeding and the genetic contamination of the wild population. Selecting an appropriate cross section of adult spawners can also help to preserve genetic diversity in the species. Tagging hatchery-produced fish could allow for selective commercial and sport fishery harvest, reducing the impacts of harvest upon wild populations of fish.

COTTONWOOD CREEK STAGE 1 ACTIONS

ACTION 1: Relocate gravel mining operations from the active channel and nearby floodplain to higher terraces.

RATIONALE: Since the completion of Shasta Dam, Cottonwood Creek has become the single greatest source of coarse sediment for the Sacramento River, supplying approximately 85% of the gravel introduced into the river between Redding and Red Bluff. Cottonwood Creek drains a portion of the Coast Range, which is composed of geologic deposits that generally produce greater quantities of coarse sediment per unit of area than the Sierra Nevada or Cascade Ranges. Cottonwood Creek also provides the cold water pool habitat that spring-run chinook salmon and steelhead trout require.

Instream and floodplain gravel mining in the lower reaches of Cottonwood Creek represent the greatest stressor upon ecological processes in the creek's watershed. The removal of sand and gravel from the creek channel deprives the Sacramento River of important gravels necessary to create and maintain spawning habitat for anadromous fish. Dams on the mainstem Sacramento River (Shasta) and Clear Creek tributary (Whiskeytown and Clair Hill) prevent the transport of coarse sediment; however, there are no major dams on Cottonwood Creek or its tributaries. Relocating gravel mining operations from the active channel and nearby floodplain will

restore the important ecological process of sediment transport and allow Cottonwood Creek to contribute a greater load of coarse sediment to the gravel-starved Sacramento River.

Gravel mining practices on lower Cottonwood Creek can also prevent or delay the upstream migration of adult anadromous fish. Gravel mining operations can spread gravel over a wide area to reduce the velocity of streamflow, which encourages greater deposition of coarse sands and gravels, thereby making more material available for mining. Spreading the flow over a larger area often eliminates the low-flow channel and reduces water surface elevations so that adult anadromous fish are impeded from migrating upstream to valuable holding and spawning habitat. Relocating gravel mining operations from the active channel and nearby floodplains will allow a low-flow channel to form, providing greater access to upstream habitat.

The extraction of gravel from floodplain deposits can form large pits that are separated from the main river channel by relatively narrow levees or berms. High flows can often breach the levees or berms and capture the deep gravel pits, which then provide warm water habitat for non-native and invasive species that prey upon juvenile salmonids attempting to emigrate from the creek. Relocating gravel mining operations from the nearby floodplain will help prevent the capture of mining pits and thereby reduce the risk of predation for emigrating juvenile salmonids.

By disturbing and removing the gravel substrate of the channel, instream gravel mining operations can also reduce the production of aquatic invertebrates that are an important component of the foodweb.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Evaluate rates of gravel recruitment to the channel from channel erosion of bank deposits and events in the watershed such as wildfires and landslides

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ACTION 2: Develop and implement a watershed management plan in concert with local stakeholders and local, state, and federal public agencies to reduce the amount of fine sediments introduced to the creek channel, to protect and restore riparian habitat, to improve base flows, and to reduce water temperatures.

RATIONALE: Activities in the Cottonwood Creek watershed can increase erosion rates and introduce excessive loads of fine sediments to the creek channel. Untimely pulses of fine sediments can clog or bury spawning gravels, suffocating the incubating eggs of anadromous fish or preventing salmonid fry from emerging from the gravels. Fine sediments can also fill in the deep water pools that adult spring-run chinook salmon and steelhead trout require to survive high summer temperatures. Developing a watershed management plan to manage road construction, timber harvest and cattle grazing in the watershed can help prevent the introduction of too many fine sediments to the creek channel. Managing the fuel load in the watershed can also help prevent catastrophic wildfires that can denude vast areas of vegetation.

Developing a watershed management plan that protects and restores riparian vegetation can provide several ecological benefits. In addition to providing habitat for a variety of wildlife species, riparian buffers can help to trap fine sediments from reaching the stream channel. Riparian vegetation can also help reduce stream temperatures by providing shading, especially for pools that adult spring-run chinook salmon and steelhead trout use for holding during the summer. Riparian vegetation also helps create cutbanks that provide important rearing habitat for juvenile salmonids. Riparian vegetation also provides nutrients and woody debris to the creek channel, helping to stimulate food production and to provide diverse aquatic habitat.

Riparian vegetation can also help to retain stormwater runoff, helping to reduce peak flows in the channel and the concomitant flood risk to downstream reaches. Retention of stormwater runoff can also help increase the amount of water that percolates into groundwater aquifers, which can in turn help to increase groundwater discharge to the stream channel that enhances base flows.

Creating a watershed management group can help bring together private landowners and local stakeholders with local, state, and federal agency personnel to help develop and coordinate

watershed management activities. The watershed group can provide a focused forum for the exchange of ideas and for building consensus among stakeholders, helping to provide a structure for continued public participation in decision making and to help build public support for long-term ecosystem restoration and management.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- determine the relative contribution of fine sediments to the channel from natural and human disturbances in the watershed
- evaluate how the restoration of upland and riparian habitat affects the transport of fine sediments to the stream channel
- as riparian vegetation is restored, evaluate the volume of stormwater runoff retained, rates of water percolation to groundwater, and groundwater discharge to the channel during base flow
- as riparian vegetation is restored, evaluate its effects upon water temperatures

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

In the FY '98 round of funding for CALFED Restoration Coordination Program, funds were provided to assist the formation of a Cottonwood Creek Watershed Group. It is anticipated that this group will help to stimulate the development of a watershed management plan.

FY '98 Category III funds have been provided to allow the formation of the Cottonwood Creek Watershed Group.

BUTTE CREEK STAGE 1 ACTIONS

ACTION 1: Improve fish passage at diversion dams either by providing alternative diversion structures that will allow removal of existing dams or by upgrading fish ladders and screen diversions.

RATIONALE: Several diversion dams on Butte Creek currently delay or impede the upstream migration of adult anadromous fish and entrain juvenile salmonids emigrating from the system in unscreened diversions. Improving fish passage and reducing entrainment at each of the diversions will help provide better access to upstream spawning habitat and increase the number of juvenile escaping to the Sacramento River.

CURRENT OR RECENT RESTORATION ACTIVITIES OR INVESTIGATIONS:

FY '97 CALFED Restoration Coordination Program funds, as well as earlier Category III funds, have been provided to help fund the design, evaluation, and construction of alternative diversion structures or upgraded fish ladders, as well as screened diversions, at the Adams Dam and Gorrill Dam diversions. Earlier Category III funds helped to finance alternative diversion structures, upgraded fish ladders, and screened diversions at the Durham Mutual Dam, Parrot-Phelan Dam, and Western Canal Water District diversions.

ACTION 2: Improve instream flows by purchasing water from willing sellers or providing alternative water supplies that will allow diverters to reduce diversions. (Note: this water will be part of the 100 TAF of water purchased to improve stream flows in the Sacramento and San Joaquin Basins.

RATIONALE: In dry years, insufficient flows in Butte Creek can impede the upstream migration of adult anadromous fish because there is too little water in the channel to provide passage over obstacles or because elevated water temperatures create a temperature barrier. Low flows and elevated water temperatures can also stress or kill juvenile salmonids rearing or emigrating through Butte Creek. To ensure long-term water supplies that will provide adequate passage flows of suitable temperatures, it will be necessary to acquire water from willing sellers or to work with local diverters to develop alternative water supplies that will allow more water to stay in the channel during dry years. It will also be necessary to balance the ecological benefits of water diverted from Butte Creek for seasonal wetlands on state and federal refuges and private duck clubs with the benefits of water left in Butte Creek to benefit salmonids.

ADAPTIVE MANAGEMENT CONSIDERATIONS:

- Determine the flows necessary to provide fish passage over obstacles
- Evaluate the relationship between flows and